Correlating Temperature and Process Corners

ECE 7502 Project Presentation

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Problem

1. Pre-Si testing for variations can be time consuming.
   - How can we reduce the number of tests required to exhaustively test a circuit Pre-Si?

2. Are there ways of managing failures due to manufacture at non-TT corners post-Si?
   - For a circuit manufactured at a non-TT corner, are there conditions under which that circuit will behave like TT @ 27˚C?

Hypothesis

- We can find temperatures at which non-TT corners behave like the TT corner at 27˚C

- Goals:

1. Reduce the number of tests required to exhaustively test a design

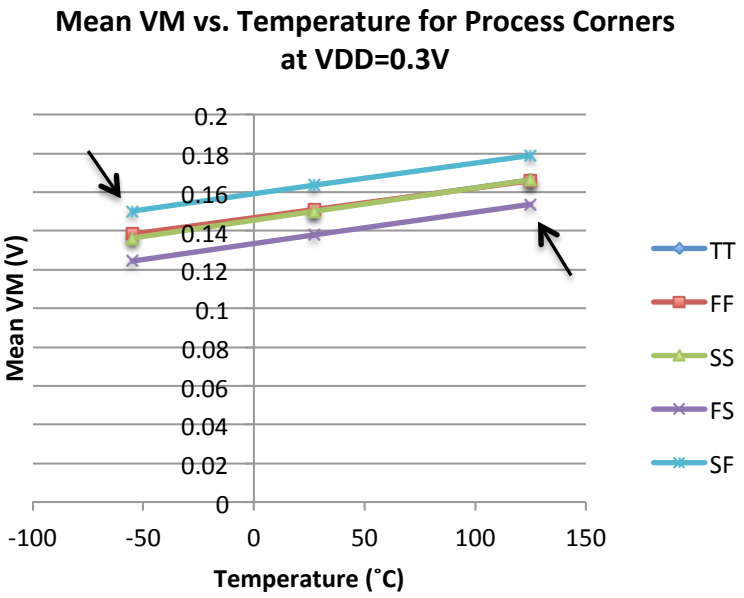
2. Provide a method for circuit balancing post-Si when designs fall in non-TT corners

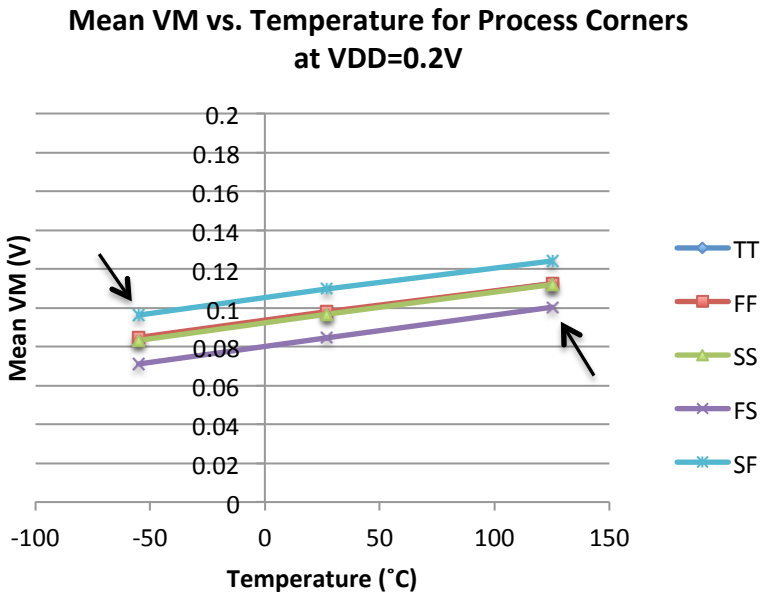
Approach

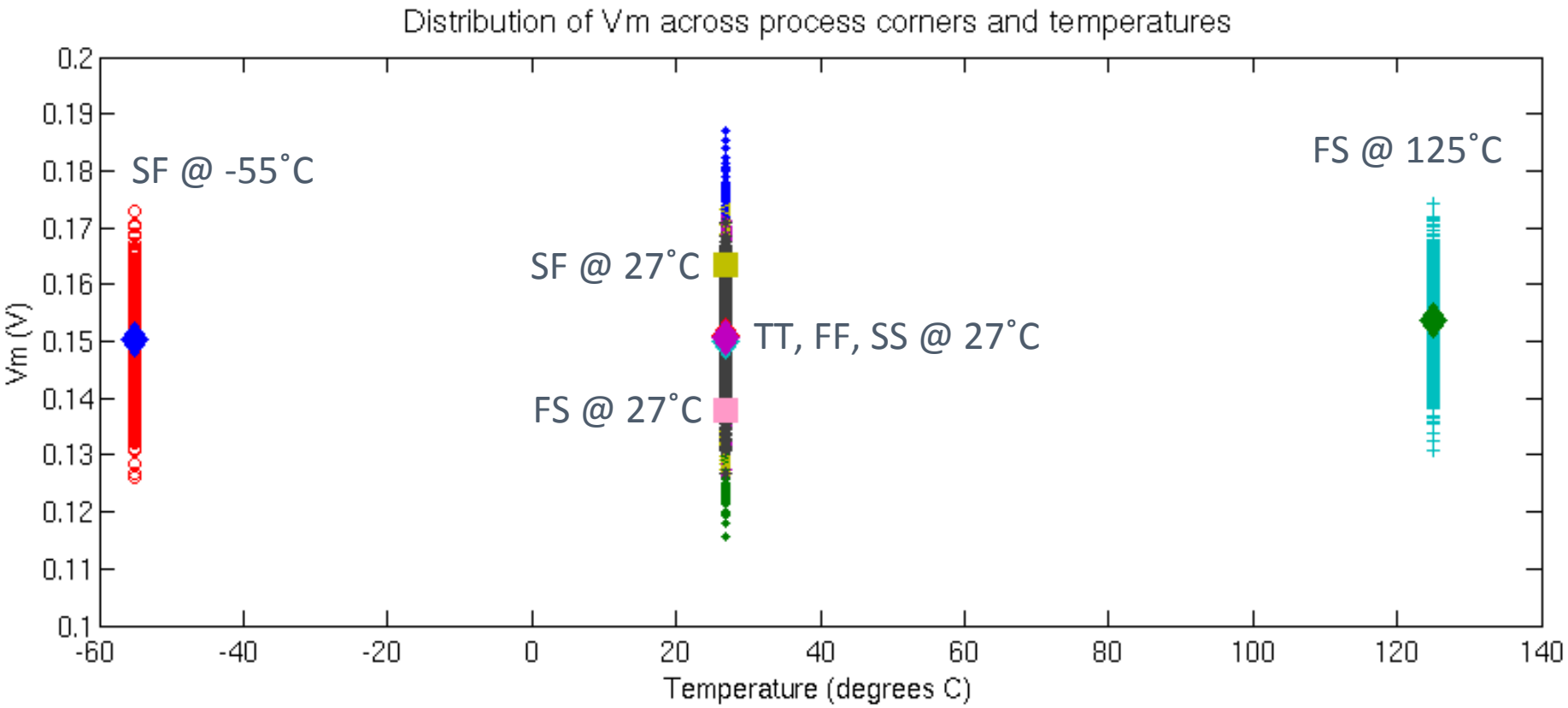
- Find distribution of V_M across temperatures and process corners for inverter
- VDD
  - 0.3V, 0.2V
- Process Corners
  - TT, FF, SS, SF, FS
- Temperatures
  - -55˚C, 27˚C, 125˚C

Results

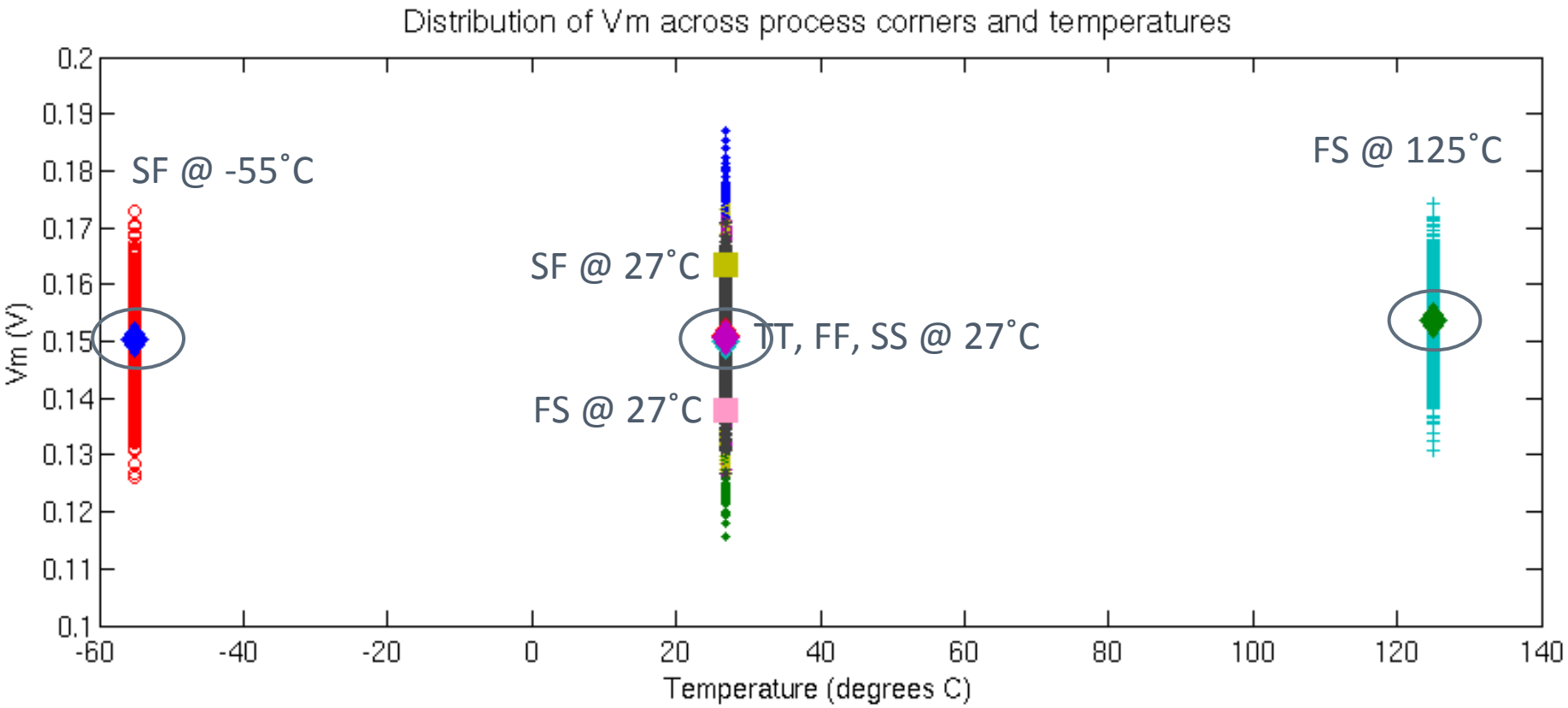
- Can see relationship is the same for 200 and 300 mV so only need to conduct analysis for one voltage






Distribution of Vm across process corners and temperatures
SF @ -55˚C
SF @ 27˚C
TT, FF, SS @ 27˚C
FS @ 27˚C
FS @ 125˚C
Vm (V)
Temperature (degrees C)
0.2
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.1
-60
-40
-20
0
20
40
60
80
100
120
140

VDD = 300 mV


Distribution of Vm across process corners and temperatures
SF @ -55˚C
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Vm (V)
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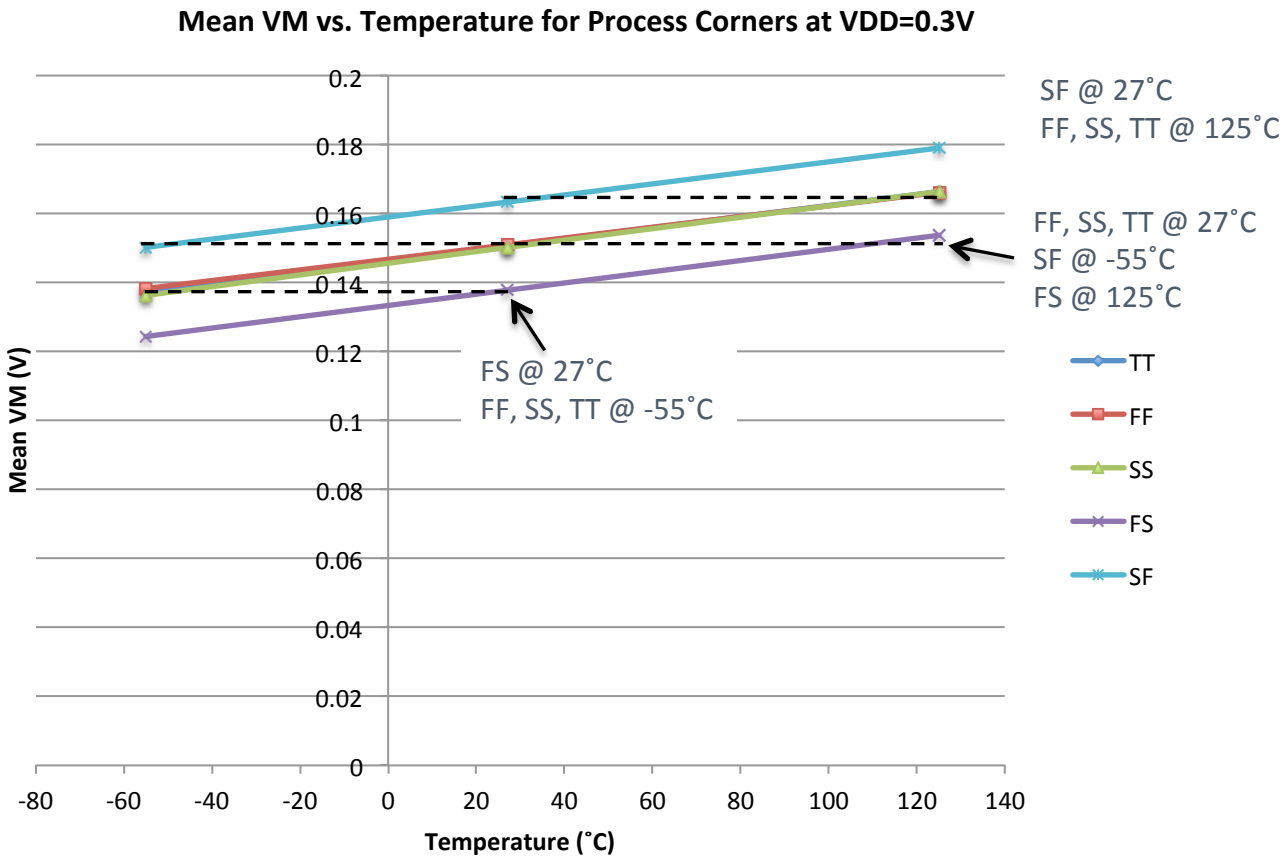
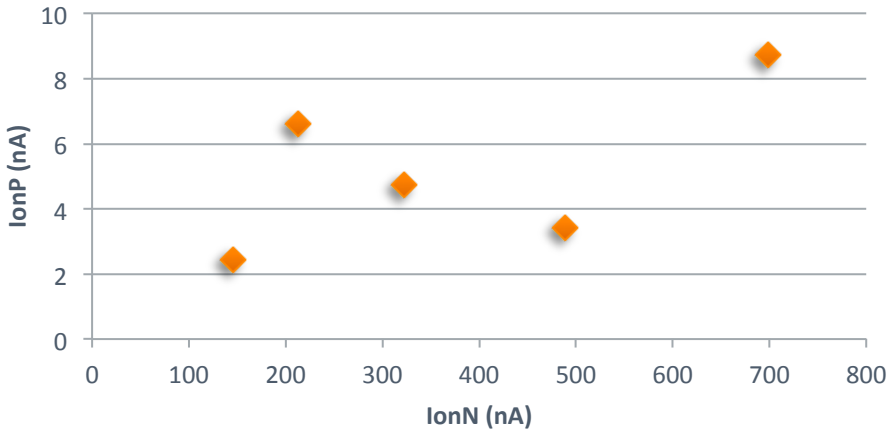
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.1
-60
-40
-20
0
20
40
60
80
100
120
140

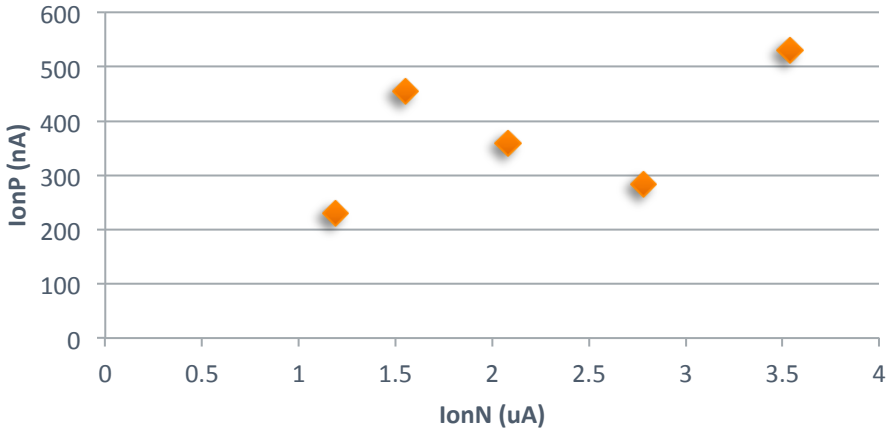
VDD = 300 mV


Mean VM vs. Temperature for Process Corners at VDD=0.3V
Mean VM (V)
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
-80
-60
-40
-20
0
20
40
60
80
100
120
140
Temperature (˚C)
SF @ 27˚C
FF, SS, TT @ 125˚C
FF, SS, TT @ 27˚C
SF @ -55˚C
FS @ 125˚C
FS @ 27˚C
FF, SS, TT @ -55˚C
TT
FF
SS
FS
SF

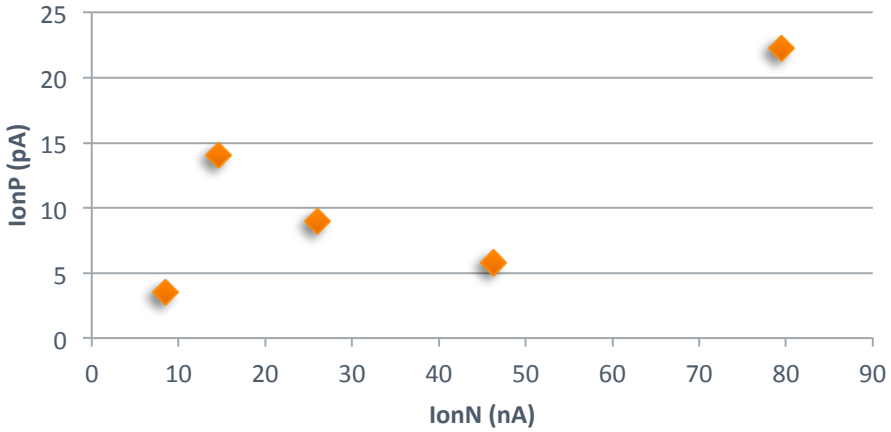
Process Corners (27˚C)

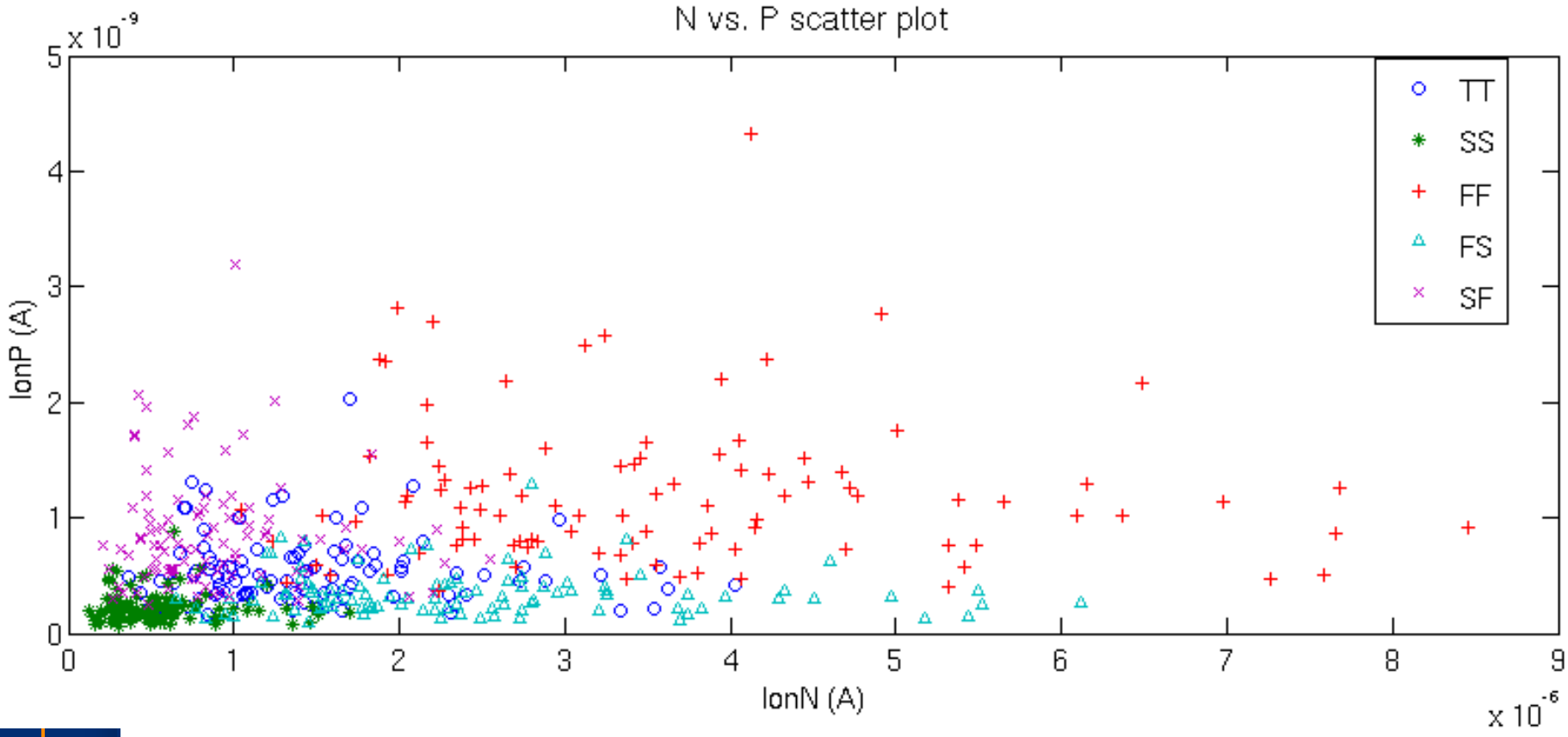


Process Corners (125˚C)

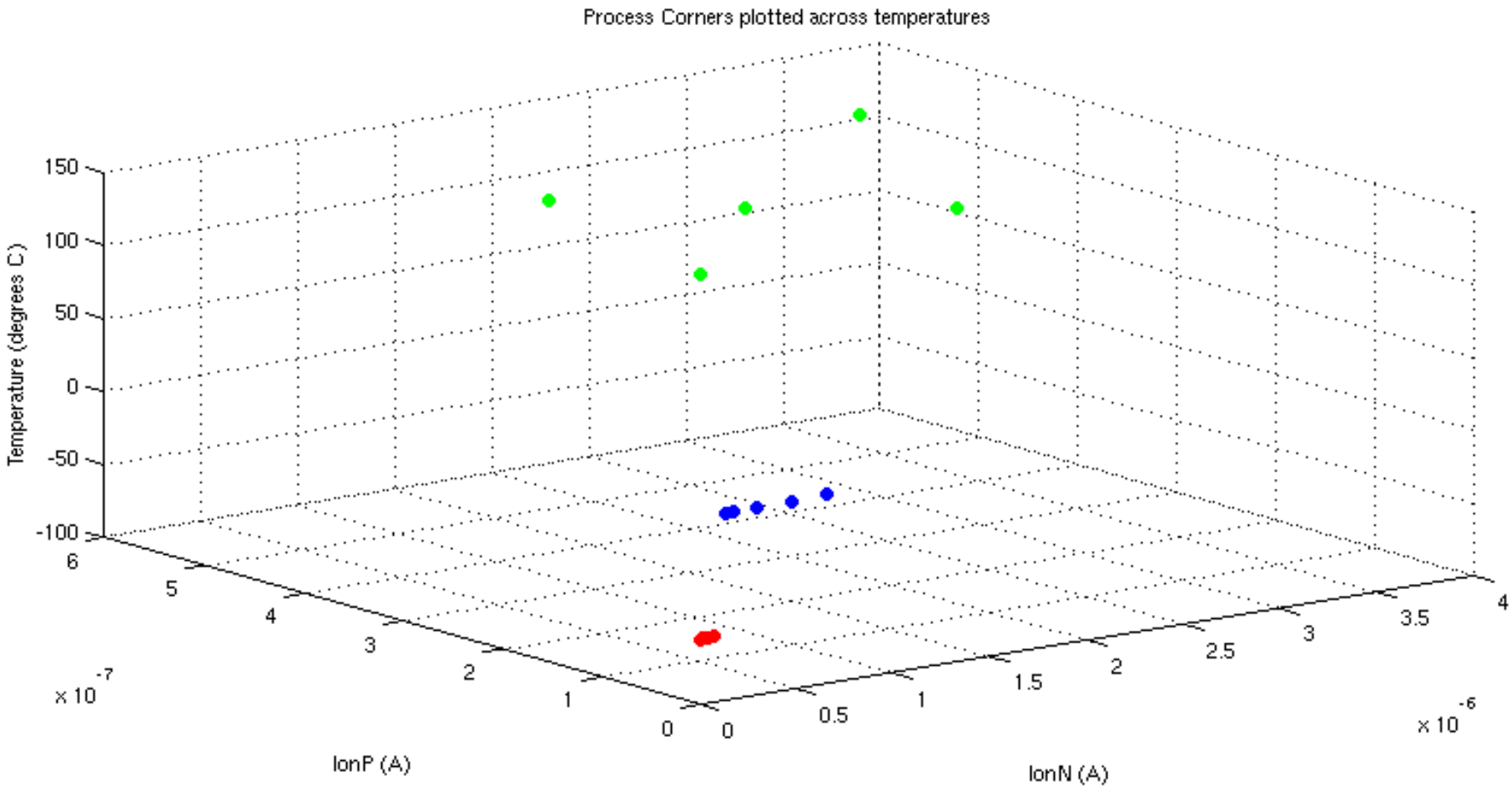


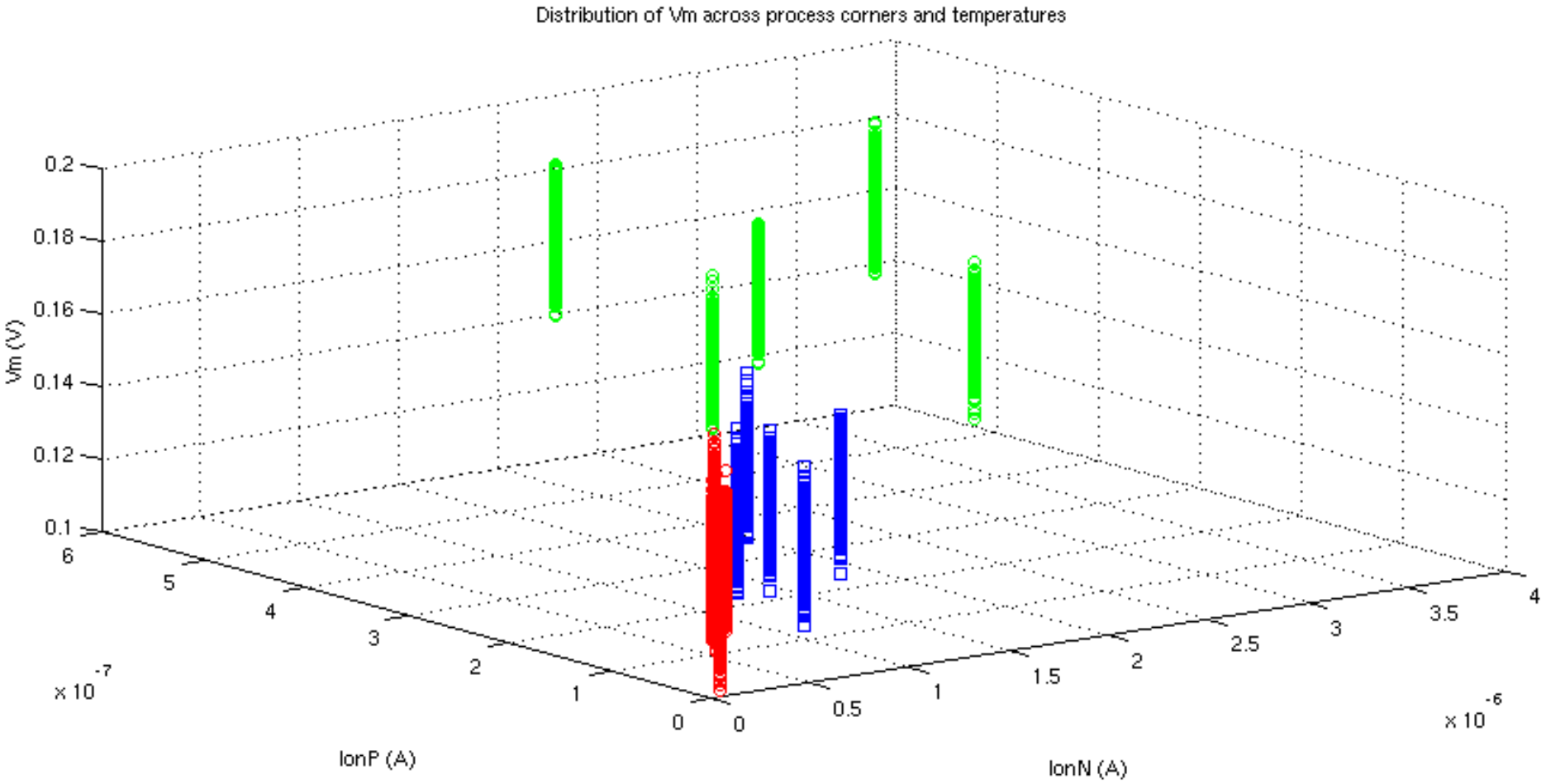
Process Corners (-55˚C)





300 mV and 27˚C


Process Corners plotted across temperatures
Temperature (degrees C)
150
100
50
0
-50
-100
6
5
4
3
2
1
0
x 10^-7
IonP (A)
0
0.5
1
1.5
2
2.5
3
3.5
4
x 10^-6
IonN (A)


Distribution of Vm across process corners and temperatures
Vm (V)
0.2
0.18
0.16
0.14
0.12
0.1
6
5
4
3
2
1
0
x 10^-7
IonP (A)
0
0.5
1
1.5
2
2.5
3
3.5
4
x 10^-6
IonN (A)

Conclusions

- Can run fewer corners simulations
  - May not need to run SS, FF
- Can run SF at -55˚C and FS at 125˚C and achieve same operation as TT at 27˚C